Energy efficiency:
future improvement

Background Paper

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ENERGY EFFICIENCY: FUTURE IMPROVEMENT

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OVERALL POTENTIAL FOR FUTURE IMPROVEMENT

It is generally recognized that there is considerable untapped potential for energy improvements in the Canadian economy. Studies show that energy demand could be reduced significantly through techniques that are economic at today's energy prices.

Estimates produced by the International Energy Agency and EMR suggest an efficiency improvement potential of 20-30%, using currently available technologies.(1) The only measures under consideration are those that are economically viable and do not reduce the overall output of goods and services.

Other evaluations of the potential for further efficiency gains have provided even more optimistic estimates. The House of Commons Standing Committee on the Environment, in its March 1991 report on climate change, itemized a number of potential end-use efficiency applications. The average potential reduction across all of the sectors examined amounted to approximately 40%.(2) In 1988, an update of a 1983 soft energy path analysis concluded that Canada could achieve a reduction in primary energy intensity of up to 50% by the year 2025.(3)

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(1) International Energy Agency, *Energy Conservation in IEA Countries*, Organisation for Economic Co-operation and Development/IEA, Paris, 1987; and Energy, Mines and Resources Canada, Policy and Coordination Branch, "Consultation Paper on Energy Efficiency in Canada," May 1987.

(2) House of Commons, Standing Committee on Environment, *Out of Balance: The Risks of Irreversible Climate Change*, March 1991, p. 32.

(3) Ralph Torrie and David Brooks, *2025: Soft Energy Futures for Canada - 1988 Update*, February 1988.

More recently, a study prepared for EMR by the management consulting firm Peat Marwick Stevenson and Kellogg produced estimates of the overall potential for energy demand reduction by the year 2000, for both the residential and commercial sectors.(4) Taking into account only the "economically attractive" energy saving potential, based on technologies that are commercially available and do not affect service levels, the study found that the potential for energy demand reduction by the year 2000 was in the order of 30% from the demand forecast for each of the above sectors.(5)

The study did not attempt to ascertain how much of the potential could in fact be realized. It did, however, conclude that stabilizing greenhouse gas emissions at current rates through energy efficiency initiatives alone would represent a major challenge, given the present world oil price environment and the many barriers to energy efficiency.

When assessing the findings of efficiency studies such as these, one must be careful to distinguish between various definitions of energy efficiency potential. In this regard, it is useful to define "technical potential" and "market potential."

"Technical potential" pertains to energy efficiency improvements that are possible given the current state of technology but without regard to economic cost. From this perspective, it is clear that the Canadian economy could operate on a minute fraction of the energy it currently uses. To reach this stage, however, would require massive investments in energy conservation, from which direct economic benefits would be unlikely. Moreover, "the technical potential" scenario often assumes a 100% penetration of economically attractive technologies that are currently available, an assumption that may be somewhat foolhardy, given the uncertainties that exist.

"Market potential," on the other hand, refers to energy efficiency improvements that would come about merely in response to market forces and independent of any intervention by governments. By definition, these improvements would entail direct economic benefits. It

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(4) Peat Marwick Stevenson and Kellogg, *The Economically Attractive Potential for Energy Efficiency Gains in Canada*, Report prepared for Energy, Mines and Resources Canada, Toronto, May 1991.

(5) William D. Jarvis, "Energy Efficiency and Substitution Overview Focus on Residential and Commercial Sectors," Speech to a conference on global warming (*The Search for Cost-Effective Action*), Calgary, May 1991.

is widely acknowledged, however, that market forces alone may result in only modest energy efficiency improvements.

Determining the true potential for energy efficiency improvements is thus not a straightforward task. It necessarily entails what can only be called a political decision -- what is deemed to be "reasonable." For example, some efficiency improvements will pay for themselves almost immediately, while others will never save money even though they may be worth making for social reasons. Still other energy efficiency improvements, while possibly reducing energy use marginally, would be so expensive as to result in a net detriment to society.

Another difficulty with these studies, which generally rely on static cost-benefit analyses, is their failure to take into account the dynamic effects of gains in energy efficiency on future consumption. According to the so-called "rebound" effect, any rise in energy efficiency brings about a drop in the implicit price of energy, which in turn could stimulate an increase in energy consumption. To put this in practical terms, if a new car is twice as fuel-efficient as the one it replaces, the cost of a given trip to the owner of the new vehicle has been reduced by one-half. This reduction in operating cost provides the owner with an incentive to take longer trips, thereby raising his gasoline consumption in the direction of his previous consumption.[6]

In the jargon of the economics profession, it then becomes a question of whether the income effect for the consumer of reduced gasoline cost outweighs the substitution effect of moving to greater efficiency. Until additional academic research is undertaken on the net effect of these opposing forces, it is perhaps somewhat premature to speculate on precisely how the "rebound" effect would impinge on the overall efficiency potential. Suffice it to say that the effect is recognized as a "non-trivial" factor by a number of leading efficiency proponents.

It is unlikely that market forces by themselves will be able to achieve very high levels of penetration of the energy-saving technologies. To overcome the current barriers to energy conservation so as to maximize efficiency potential may require government intervention.

Obviously, any national strategy to lower energy intensity in the order of 20-30%, for example, would require a lengthy introduction period. To do otherwise would subject the

(6) *Ibid.*, p. 6.

national economy to a potentially serious shock. To this end, the House of Commons Environment Committee recommended in its interim report on climate change that the target should be to lower energy intensity by 2% each year.(7) If this annual reduction target was achieved, the desired efficiency result would be attained over a period of some 10-15 years.

Unfortunately, to achieve the 2% target would require major modifications in energy use and without substantial government intervention would be difficult to achieve, particularly at a time when the price of oil has fallen, and the real price of oil is well below the levels of the early 1970s. Even with the government information programs and the substantial subsidies provided to consumers and businesses in the 1970s and early 1980s, our reduction in energy intensity was below international norms and well below the 2% threshold.

SPECIFIC SECTORAL OPPORTUNITIES

Keeping in mind the limitations noted above, and detailed in the document "Energy Efficiency in Canada" (Library of Parliament BP-304E), this paper will examine some of the technologies currently available to improve energy efficiency in each of the four end-use sectors: residential, commercial, industrial and transportation. Where possible, estimates of the costs of implementing the technologies are also given, along with estimates of typical payback times.

A. Residential

In the residential sector, energy is used primarily for space and water heating, for lighting and for operating appliances. The Department of Energy, Mines and Resources notes that the average energy intensity per house in Canada has been reduced by some 32% over the past ten years through more energy-efficient building design and the development of less energy-intensive appliances and heating systems. It further notes that, despite these impressive gains,

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(7) House of Commons Standing Committee on Environment, *No Time to Lose: The Challenge of Global Warming*, Ottawa, 1990, p. 6.

more energy savings are possible. Following is a brief review of some of the areas in which additional savings are possible.

In a recent paper, Hayden and Braaten note that by retrofitting or replacing existing space and water heating equipment fired by oil, natural gas or electricity with new, high-efficiency, low-emissions technology, and by using similar systems in new home construction, fuel consumption (and consequently, CO_2 emissions) can be lowered by between 20 and 47%.(8)

The importance of the retrofit market in the residential sector cannot be overstated. If major improvements in energy efficiency are to be achieved over the next decade, the existing stock must be upgraded. New equipment for which it is possible to regulate efficiency levels will be coming on line too slowly to have much impact in the near and mid-term. The modifications that can be made to existing heating systems are numerous and the above-mentioned paper outlines a number of the most promising.

In many parts of the country, oil is still the prime residential heating fuel and so we will first look at methods for improving the efficiency of oil-fired space heating systems. First, one can reduce the firing rate so that the furnace is more in tune with the heat demands of the home; resulting energy savings are lowest at mild temperatures and increase as outside temperatures decrease. There is, of course, a lower limit to the level of firing since at too low a level excess air will be needed to allow for proper combustion, and this will again reduce efficiency. Other simple devices such as delayed action solenoid valves and chimney (vent) dampers can also help improve the operating efficiency of existing furnaces.

Conventional burners on oil furnaces operate at a seasonal efficiency of about 60%. By changing the burner to a new high-pressure drop, flame retention head unit this can be improved to 75%. In other words, fuel saving (and a CO_2 reduction) of 20% is possible. In some cases a stainless steel chimney liner will also have to be installed at the same time as the new head, to prevent deterioration of the chimney. Also, since existing furnace combustion chambers may not be suitable for the higher temperatures involved, a ceramic fibre liner should

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(8) A.C.S. Hayden and R.W. Braaten, "Retrofitting Residential Heating Systems to Improve Efficiency, Lower Electricity Demand and Reduce CO2 and Other Pollutant Emissions," *Proceedings of Energy and the Environment Conference*, Toronto, March 1991.

be installed with the new burner head.[9] The new burner would cost between $400 and $600 including installation, and the ceramic fibre liner only an additional $30. If a steel chimney liner is needed, the cost would be about $600 more. The payback time for the consumer would depend on his annual heating costs to begin with, but to give a rough idea, let us assume a total system cost of $1,000 to $1,500, an annual fuel bill of $1,000 and fuel savings of 20%. Payback time would then be from five to seven and a half years.[10]

In addition to these add-on improvements, new, advanced-efficiency oil furnace systems that may be used with induced or forced draft are in the final stages of development. They have the potential to raise the seasonal efficiency to 85%, with a resultant fuel and CO_2 reduction of about 31%. The system can be operated without the need for a chimney, with the combustion products simply being vented through a side wall in the house.[11] The estimated cost of a new system is about $1,200 installed if an induction fan is needed, and about $1,000 if it is not. A consumer could face offsetting savings by not requiring costly chimney repairs that might otherwise be needed. For new homes one might be able to avoid the need for a chimney altogether (depending on the water heating system used, and the presence or absence of a fireplace). Typical payback periods are expected to be about four to five years, again depending on the current heating costs.[12]

In terms of improvements in the energy efficiency of building design, Canada has been, and continues to be, a world leader. Our R-2000 technical standards offer significant energy savings, with a relatively small consequential increase in building costs. There has also been a great deal of effort put into transferring the technology to Canadian home builders and workshops for them have been generally well attended. It is estimated that about 20,000 houses have been built to R-2000 standards since the program began. In the past, builders were

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(9) *Ibid.*, p. 2.

(10) Personal communication, A.C.S. Hayden, Energy Conservation Technology Section, Canadian Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, August 1991.

(11) Hayden and Braaten (1991), p. 3.

(12) Hayden (1991).

reluctant to provide such super efficient housing since buyers were largely unaware of the potential savings and saw only the increased upfront costs. However, as noted above, the cost added by implementing these or similar measures at the time of construction does not add significantly to the overall cost of the new house. For example, in one house valued at $175,000, the extra cost for added insulation, a high efficiency gas furnace, the best available new window technology and energy-efficient appliances was just $3,000. In exchange for this modest ($20 per month) increase in mortgage payment the cost of heating the 2,200 square foot home (located in Chicago) is less than $200 per year.(13) Similar examples can be found in Canada.

Canada has also launched a research and development program designed to add further to the energy efficiency of houses built in this country. The Advanced House project in Brampton includes a series of new projects and technologies such as integrated mechanical systems, energy efficient appliances and lighting (compact fluorescent bulbs) as well as passive solar heating. This demonstration project hopes to show that it is possible to build a house that uses just 41% of the energy used in an equivalent R-2000 house. The question of cost will also become clearer once this new house is up and operating. The Department of Energy, Mines and Resources has estimated that if all new houses were built to the R-2000 standard by 2000, then in the residential sector it would be possible to achieve, or at least come close to achieving, the target of stabilizing CO_2 levels.

The above discussion mentions new window technology, an area of research being pursued here in Canada. The goal of the federally supported research is to develop a window with a thermal insulation value of RSI 1; in layman's terms this means a 300% improvement over conventional windows. Energy, Mines and Resources has estimated that if just half of the new windows installed in Canada used such a technology, in the first year alone there would be an energy savings across the country of some $73 million, savings that would continue to compound over the lifetime of the window. At the moment consumers do have a choice between conventional windows and low emissivity (low-E) glass, and can also go to low-E glass with argon gas between the two panes. The biggest barrier to increased use of the improved windows

(13) "Conservation Power," *Business Week*, 16 September 1991, p. 91.

is capital cost, although, as high-performance windows gain acceptance and penetrate the market, the cost differential will be reduced.

Research in other countries has led to the development of window systems offering reductions in heat loss of from 50 to 90% over conventional windows. For example, a Canadian company, Visionwall Technologies Inc. of Edmonton, has the North American rights to a Swiss window technology in which two low-emissivity films are suspended inside two panes of glass. The company is making inroads into both the Canadian and U.S. markets and over the last year, advances in the production methods have reduced costs by as much as 30%. In new construction, the company works with developers to ensure that the high efficiency windows are part of the initial design of a new building, and that the heating and cooling requirements are appropriate. The capital cost savings from reduced heating and cooling requirements offset the modest additional capital costs of the windows, making this technology competitive in today's market. The windows have also found a niche in the retrofit market, particularly in situations where a high humidity level is maintained on the inside during the winter season (for example in swimming pools and in museums), where the low conductivity of these windows virtually eliminates condensation.(14) Clearly there is a great deal of potential for improving the energy efficiency of windows in this country.

Household appliances account for about 18% of household energy consumption in Canada. In an attempt to influence consumers purchasing appliances, the federal government put in place the Energuide program, which involves the testing, rating and labelling for energy consumption, all models of refrigerators, freezers, washers, dryers, stoves and dishwashers sold in Canada. The original program was administered by Consumer and Corporate Affairs, but now this task will be transferred to the Department of Energy, Mines and Resources. In addition, the Energuide label will be redesigned to give consumers more information on which to base their choice of products. National minimum energy performance standards will also be established for the same range of products as covered by the existing program. The legislation implementing these changes is sufficiently flexible that additional energy-using devices can be

(14) Personal communication, Don Holte, Chairman, Visionwall Technologies Inc., Edmonton, 23 April 1992.

brought under the umbrella of national standards as this action is deemed appropriate. Four provinces have already implemented minimum performance standards for appliances or are planning to do so and the federal government felt that it was time to establish national standards to avoid a patchwork of regulations and possible dumping of inferior products from one province to another. Under the terms of this legislation, there should be a gradual improvement in the overall energy efficiency of appliances in Canadian homes.

Clearly, despite a great deal of progress, there is still scope for a great improvement in residential energy efficiency in Canada, and much of it can be achieved economically with today's energy prices and today's technology. Table 1, which is taken from a report by the House of Commons Standing Committee on the Environment, presents one expert's view of the potential for efficiency improvements in this, and other sectors of the economy. Another study, done for the Department of Energy, Mines and Resources, estimates an economically attractive potential for energy savings of 44% for residential space heating and 11% for residential appliances.(15)

B. Commercial

Table 1 shows that there is also considerable scope for improving energy efficiency in the commercial sector. The three areas of potential savings are noted as space conditioning (i.e., heating and cooling), lighting and motors. We will look briefly at the technologies that would allow these savings to be realized. It is worth noting that none of these technologies is still in the R&D stage. They are commercially available and, as more and more building managers are discovering, their payback times are very attractive.

Turning first to heating and cooling systems, the installation of computer systems that monitor temperature variations and maximize the use of the building's heating and cooling system have proven to be very successful at reducing energy consumption. "Energy management" is clearly showing itself to be well worth the investment for those charged with operating hospitals, hotels, convention centres, office complexes and schools. In the Kingston

(15) Peat, Marwick, Stevenson and Kellogg (1991), p. vi.

Table 1

Some Key Areas of Potential for Increased Energy Efficiency in Canada

Sector	End-Use	Measures	Sample Technologies	Efficiency Potential*
RESIDENTIAL	Space Heating & Cooling	- building shell improvements - heating system efficiency improvements	- insulation - seating - superwindows	53%
	Appliances	- more efficient appliances	e.g.- insulation - bulbs - motors	30%
COMMERCIAL	Space Conditioning	- building shell improvements - better controls	- insulation - seating - integrated control systems	53%
	Lighting	- improved lighting systems	- bulbs	60%
	Motors	- improved motors	- drives, controls efficient motors	35%
INDUSTRIAL	Process Heat	- heat recovery - improved heating systems	- insulation - cascading - advanced heating sytems - cogeneration	32%
	Mechanical Drive	- improved motors	- variable speed drives - linkage systems - more efficient motors	22%
TRANSPORTATION	Auto/Bus Trucks Rail Air Marine	- vehicles efficiency - higher load factors	- weight and size reductions - improved aerodynamics - improved engine efficiency - reduced rolling resistance - variable speed transmissions	45% 35% 38% 40% 35%

* Rough estimates, averaging across new and existing buildings, processes and activities

Source: House of Commons, Standing Committee on the Environment, *Out of Balance: The Risks of Irreversible Climate Change*, March 1991, Table E, p. 32.

area, for example, the Frontenac Board of Education undertook a four-year energy efficiency improvement program which involved all 50 of its schools and would cost an estimated $1 million. The total energy savings over the same time frame amounted to $1.2 million.[16] Much of the savings came from the computerization of each school's heating and cooling system, allowing for a better match between energy supply and demand throughout the school. At the University of Guelph a similar approach was taken. All 60 buildings on the campus are heated and cooled from a central plant. It cost approximately $400,000 to install a new variable speed pump for the facility, to replace the old one-speed pump. The new pump varies the flow of water through the system to match the demand for air conditioning and in the process saves the university $100,000 per year in electricity. This fast four-year payback was made even more attractive by a $200,000 rebate on the capital expenditure from Ontario Hydro. Over the life of the project, the utility would have paid an estimated $1.5 million to produce the energy that is now being saved.

Such "smart" energy systems offer savings to other similar establishments and will result in a net dollar savings rather than a cost to those installing them. It is also possible that the energy- efficient condensing technologies for the gas furnaces described earlier and which were developed for the residential market, could also be applied to commercial boilers. It is estimated that these furnaces could offer a further reduction in energy consumption of 20-30%, but the cost of such a system on a commercial basis is not yet known.

Lighting in commercial buildings represents a significant part of their overall energy consumption. Table 1 indicates that savings of as much as 60% are "technically" feasible. Other estimates vary somewhat but the potential savings appear to be truly substantial. Over the last 20 years there has been a gradual movement, first from incandescent lighting to the more efficient fluorescent lighting and then to progressively lower wattage fluorescent lights. Now the compact fluorescent light bulb, which resembles the incandescent light bulb, is making an impact on the market. You can replace a 75 watt incandescent bulb with a 15 watt compact

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(16) "Electric Options," *Ontario Hydro*, No. 45, September 1990.

fluorescent bulb and receive the same amount of light for 13 times longer, cutting your energy bill by 80-90% over the lifetime of the bulb.[17]

Of course, consumers have to be convinced that it will be worth the added investment in a compact fluorescent bulb to achieve this savings over the long-term, since the new bulbs can cost up to $30 each. Commercial establishments, in which the annual bill for lighting can amount to hundreds of thousands of dollars a year, are beginning to look much more closely at this technology. In addition, it is possible to improve the efficiency of existing fluorescent lighting, by switching to new types of ballast (which regulate the flow of energy through the tubing). Some experts believe that such measures alone could result in a 12% energy saving.

The third area in which commercial establishments can realize energy savings is by switching to new electric motors. The latest motor technology includes the use of what is known as electronic ASDs, or adjustable speed drives. As in the case mentioned above at the University of Guelph, such motors draw only the electricity that they need for the task, rather than a fixed amount as was the case with older one- or two-speed motors. It is estimated that if this technology was widely adopted it would be possible to save 10% of current electricity demand on a national basis. Again, as shown in the Guelph example, the dollar savings are attractive.

C. Industrial

The above discussion of the energy savings available from new motor technology also holds for the industrial sector. The estimates of how much energy can be saved in this way vary considerably from expert to expert. As seen from Table 1, one estimate puts the potential savings at 22%. Another well known advocate of energy efficiency, Amory Lovins, notes that more than half of the electricity in the world turns motors, and not very efficiently. With new

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(17) "Skeptics and Visionaries Examine Energy Saving," *Science*, Vol. 25, 11 January 1991, p. 154.

electronic speed controls, new materials and designs, and new drive trains, he feels that as much as 60% of the electricity bill for motors could be saved.[18]

This is an estimate of the full potential for savings, not taking into account the likely rate at which such technology will actually be taken up, an issue discussed in the paper by Peter Berg entitled "Energy Efficiency in Canada" (Library of Parliament BP-304E). Lovins goes on to note that the costs for switching to such technology are not high, since an average motor consumes its own capital costs in electricity every few weeks. He estimates that a new motor would pay for itself in about 16 months, after which all energy savings would be profit.[19]

In the industrial sector, there is also the potential to utilize a concept known as energy cascading. This has been described as "organizing the flow of energy through the various thermal systems, production processes and equipment within a plant operation, in a way which will allow for the achievement of the maximum efficiency throughout the total process."[20] Put another way, the degraded heat from one process becomes the useful heat input for another and so on until the remaining heat is discarded into the atmosphere. The use of cascading technology is limited to heat that can be easily transmitted from one place to another with little loss incurred on the way. For this reason it is essential to have a well designed system which places the processes through which the energy cascades in the correct juxtaposition. This is obviously simpler to do when designing and building a new plant than when trying to retrofit an old one. It is estimated that the main energy-consuming industries in Canada - logging, mining, manufacturing and baseload electricity production - lose as much as 40% of the energy they use into the environment in the form of gaseous and liquid waste heat streams. Technically speaking, as much as 25% of this waste heat is recoverable using cascading

(18) "Conservation Power" (1991), p. 155.

(19) *Ibid.*

(20) Ministry of State for Science and Technology, "Energy Conservation Technologies and Their Implementation," Supply and Services, 1982, p. 69.

technology.[21] Waste heat recovery is of special interest to the steel and pulp and paper industries where there is significant use of high temperature materials.

A second area that offers improved energy efficiency is the use of co-generation technologies. In Europe the more descriptive name given to this process is combined heat and power systems. In such a system the excess heat from the industrial process can be used to generate electricity for use in the industry itself or, if regulatory problems are minimized, for sale to the electric utilities. Again the pulp and paper industry, along with the steel industry and chemical manufacturers, would have the greatest potential for making use of this technology. In Ontario, the provincial utility is encouraging the further use of co-generation as it seeks to increase the amount of non-utility generation (NUG) in its electricity production. The utility expects that by the turn of the century there will be as much as 3300 megawatts of NUG in place. Most of this NUG will come from energy efficient co-generation projects such as the $37 million gas-fired unit which DuPont Canada is installing in its Maitland facility. The plant will generate 38.5 megawatts of electricity, half of which will be available for sale to Ontario Hydro. At the same time 136,000 kg of steam per hour will be produced for use as space and process heat. This plant will be in operation by the end of 1992.[22]

Industry is working towards an improvement in the energy efficiency of its processes and is being helped in this regard by a federal Industrial Energy Research and Development Program. The emphasis in this program is on the development side, with the government providing up to 50% of the development costs for efficiency improvements for which industry has done the research. This leverage position has been quite successful in bringing new technologies into commercial use. To date some 80 projects have been sponsored and 50% of them have been deemed to be successful (i.e., both technically and commercially viable).[23]

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(21) *Ibid.*

(22) "Conservation, Parallel Generation Important for Ontario Hydro in 1990s," *Energy Analects*, Vol. 20, No. 16, 22 April 1991, p. 2.

(23) Personal communication, Norman Benoit, Efficiency and Alternative Energy Technology Branch, Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources, 1 October 1991.

Success stories include the development of powder metallurgy, a technology that eliminates the need for energy-intensive machining of certain metal parts. The metal is instead powdered and then pressed into the desired form. In the pulp and paper industry a great deal of energy is being saved by the use of more efficient electrical motors throughout the processing plant. Also in the paper industry, the impulse drying of newsprint is resulting in great energy savings over traditional steam drying. With this new technology the roll on which the newsprint is wound is warmed by induction heating and the newsprint is dried as it is rolled. The development of water-based automobile paint is yet another example of more energy-efficient technologies developed with help from the federal program. The paint eliminates the use of oil-based solvents, and reduces drying time, and hence energy consumption.[24]

A number of other technologies are being developed by a variety of industries aimed at reducing the cost of energy inputs. In making ceramic compounds, for example, a new high temperature plasma processing technique is under development. High temperature gas will be contacted with an electric arc to produce a plasma in which the ceramic material will be processed and shaped. The technique is still in the R&D stage but offers potentially significant energy savings. The paragraph above referred to use of induction heating for drying newsprint. The same technology is being looked at by other industries where there are potential energy savings from providing high temperature heat only where and when needed, rather than in an ongoing way. The hardening of metal is one process which may benefit from the application of this technology.

While the above section outlines a variety of technical approaches to saving energy in the industrial sector, there is at the same time a notable lack of detail regarding the amount of energy that can be saved and the cost of doing so. This is because every industry, and indeed every plant operation, is unique. One would have to look at cases one at a time to come up with accurate figures. It is perhaps enough to refer again to the figures for potential savings presented in Table 1 for the industrial sector. These give an idea of the magnitude of possible energy savings. As more and more industries are discovering, these improvements usually pay for themselves quite quickly and represent a capital saving rather than a cost.

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(24) *Ibid.*

D. Transportation

Because the transportation sector is responsible for about one-third of all energy consumption in Canada, improving the efficiency of energy utilization in this sector can have a profound impact on the energy scene. Of the energy used in transportation, fully 30% is consumed by cars and light trucks, so this is the area in which improvements have been most frequently sought. Over the past two decades, considerable improvements have been realized in the fuel efficiency of automobiles. In 1975, for example, the average fuel economy of new vehicles in the United States (which sets the trend for North America) was just 18.7 miles per gallon (mpg).[25] In response to the standards set by U.S. legislation (currently at 27.5 mpg) this figure had risen as high as 28.8 mpg by 1988. Recently released figures show that the comparable Corporate Average Fuel Efficiency (CAFE) for new cars for the 1991 model year will be about the same as the 1986 level, that is just 28.2 mpg. Fuel efficiency for light trucks has followed a similar pattern, with the last two model years showing an actual decrease in efficiency over the all-time highs of the late 1980s. It has been noted that "..if improvements in fuel efficiency aren't mandated it's unlikely much progress will willingly be made by the auto industry."[26]

The bottom line is that it is still technically possible to vastly improve upon the fuel efficiency of the automobile, but consumer preference alone will not spur automakers to realize this potential. Only much higher fuel prices or mandated improvements in CAFE will accomplish the task. Technologies which are already available and cost-effective could raise the new car fleet efficiency from the current levels noted above to as much as 44 mpg by the year 2000 at an average cost to consumers of $0.55 per saved gallon. The technologies which could accomplish these savings, without necessitating any reduction in vehicle size, include aerodynamic improvements, four-valve-per-cylinder engines, front-wheel drive, multi- point injection systems, electronic transmission controls and intake valve controls. There are those

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(25) The following conversion factor can be used:
litres/100 km = 282.48/mpg
mpg = 282.48/litres per 100 km

(26) "Fuel Efficiency," *Energy Report*, 8 April 1991, p 261.

who argue that cars with such improved fuel economy would have to be smaller, and therefore less safe. This flies in the face of the fact that, between 1975 and 1988 when fuel efficiency doubled in the U.S. and the average weight of a car dropped by 1,000 pounds, traffic fatalities fell by 40%.[27]

How realistic is it to expect fuel efficiency ratings of 40, 50 or even more mpg? In Japan and Europe it is already a reality. A variety of cars, generally in the sub-compact or mini-car size range, are commercially available, each with an engine displacement lower than two litres. These models include the following four passenger cars: the Daihatsu Charade with a 1 litre engine and a city rating of 62 mpg; the Suzuki Sprint, with a similar size engine and a 65.7 mpg rating: and the Toyota Starlet, with a 1.3 litre engine and a 65.7 mpg rating.[28]

In addition, Volkswagen, Volvo, Renault and others all have prototype 4 and 5 passenger vehicles, getting anywhere from 65 to 110 mpg, in operation now. Further improvements, particularly in the area of variable speed transmissions and advanced combustion chamber designs, show promise for moving these efficiency levels still higher in the future. In perhaps no other sector is the technological ability so far ahead of standards and consumer preference. Given the importance of the transportation sector as a consumer of energy in this country, this is certainly a fertile area for improving the overall energy efficiency of the Canadian economy.

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(27) Michael Shepard, "How to Improve Energy Efficiency," *Issues in Science and Technology*, Summer 1991, p. 87.

(28) P.S. Jessup, "Carbon Emissions Reduction Options in Canadian Transportation," Discussion Paper, Friends of the Earth, 1989, p. 4.

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WILLOWDALE, ONTARIO

* INDICATES
75% RECYCLED
25% POST-
CONSUMER FIBRE

*SIGNIFIE 75 %
FIBRES RECYCLÉES,
25 % DÉCHETS DE
CONSOMMATION

BALANCE OF PRODUCTS
25% RECYCLED

AUTRES PRODUITS:
25 % FIBRES RECYCLÉES